CLAIMS

What is claimed is:

1. A method of enhancing signal tracking in a global positioning system receiver utilizing a multiple segment multiple frequency banked filter, the method comprising:

acquiring a continuous time global positioning signal;

separating the continuous time global positioning signal into in-phase and quadrature signals I and Q;

sampling the signals I and Q over a predetection interval (PDI) to provide discrete time signals;

generating from the discrete time signals a component in-phase measurement and a component quadrature measurement for each of a plurality of PDI segments of one PDI;

for each of a plurality of different frequency bins, generating for the PDI a composite in-phase measurement by combining component in-phase measurements and component quadrature measurements from the PDI, and generating for the PDI a composite quadrature measurement by combining component in-phase measurements and component quadrature measurements from the PDI; and

detecting power in each of the plurality of different frequency bins for the PDI using the corresponding composite in-phase measurement and the corresponding composite quadrature measurement generated for the frequency bin.

2. The method of enhancing signal tracking of claim 1, wherein the step of sampling the signals I and Q over the PDI further comprises sampling the signals I and Q over a PDI of approximately 20 milliseconds to provide discrete time signals.

3. The method of enhancing signal tracking of claim 1, wherein a PDI is divided into five consecutive PDI segments and wherein the component in-phase measurements for each of the five PDI segments are I_1, I_2, I_3, I_4 and I_5, respectively, and wherein the component quadrature measurements for each of the five PDI segments are Q_1, Q_2, Q_3, Q_4 and Q_5, respectively.

4. The method of claim 3, wherein generating the composite in-phase measurements for each of five frequency bins includes:

generating for a first frequency bin a composite in-phase measurement using the relationship $I_1-Q_2-I_3+Q_4+I_5$ and generating for the first frequency bin a composite quadrature measurement using the relationship $Q_1+I_2-Q_3-I_4+Q_5$;

generating for a second frequency bin a composite in-phase measurement using the relationship $I_1+I_2-Q_3-Q_4-I_5$ and generating for the second frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2+I_3+I_4-Q_5$;

generating for a third frequency bin a composite in-phase measurement using the relationship $I_1+I_2+I_3+I_4+I_5$ and generating for the third frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2+Q_3+Q_4+Q_5$;

generating for a fourth frequency bin a composite in-phase measurement using the relationship $I_1+I_2+Q_3+Q_4-I_5$ and generating for the fourth frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2-I_3-I_4-Q_5$; and

generating for a fifth frequency bin a composite in-phase measurement using the relationship $I_1+Q_2-I_3-Q_4+I_5$ and generating for the fifth frequency bin a composite quadrature measurement using the relationship $Q_1-I_2-Q_3+I_4+Q_5$.

5. The method of claim 1, and further comprising determining which one of the plurality of different frequency bins contains the most detected power.

6. The method of claim 1, and further comprising applying a delay detector function to the composite in-phase measurement and the composite quadrature measurement for the frequency bin containing the most detected power to obtain a delay detector output.

7. The method of claim 6, wherein the step of applying the delay detector function further comprises determining a delay $D^{(k)}$ for a selected frequency bin using the relationship:

$$D^{(k)} \sim \frac{\left(\begin{bmatrix} X_e^{(k)} \\ Y_e^{(k)} \end{bmatrix} - \begin{bmatrix} X_l^{(k)} \\ Y_l^{(k)} \end{bmatrix}\right) \bullet \begin{bmatrix} X_p^{(k)} \\ Y_p^{(k)} \end{bmatrix}}{\begin{bmatrix} X_p^{(k)} \\ Y_p^{(k)} \end{bmatrix} \bullet \begin{bmatrix} X_p^{(k)} \\ Y_p^{(k)} \end{bmatrix}}$$

where $\begin{bmatrix} X_e^{(k)} \\ Y_e^{(k)} \end{bmatrix} =$ early versions of the in-phase composite value (X) and the quadrature composite value (Y) for the k^{th} frequency bin;

$\begin{bmatrix} X_l^{(k)} \\ Y_l^{(k)} \end{bmatrix} =$ late versions of the in-phase composite value X and the quadrature composite value Y for the k^{th} frequency bin; and

$\begin{bmatrix} X_p^{(k)} \\ Y_p^{(k)} \end{bmatrix} =$ prompt versions of the in-phase composite value X and the quadrature value Y for the k^{th} frequency bin.

8. The method of claim 6, and further comprising:

providing a feedback output as a function of the delay detector output; and

performing the step of separating the continuous time global positioning signal into the in-phase and quadrature signals I and Q as a function of the feedback output.

9. The method of claim 1, and further comprising:

generating for the PDI prompt versions of a composite in-phase measurement $X_p^{(0)}$ and a quadrature in-phase measurement $Y_p^{(0)}$ corresponding to a frequency bin having an estimated carrier frequency error of approximately zero;

determining an arctangent of $Y_p^{(0)}/X_p^{(0)}$ to obtain a current carrier phase Θ;

subtracting a delayed version of the carrier phase Θ from the current carrier phase Θ to obtain a value $\Delta\Theta$;

providing a carrier feedback output as a function of the value $\Delta\Theta$; and

performing the step of separating the continuous time global positioning signal into the in-phase and quadrature signals I and Q as a function of the carrier feedback output.

10. The method of claim 9, and prior to providing the carrier feedback output as a function of the value $\Delta\Theta$, further comprising:

determining whether the value $\Delta\Theta$ is bounded between $\pm 180°$; and

adjusting the value $\Delta\Theta$ if it is not bounded between $\pm 180°$ by subtracting 180° from the value $\Delta\Theta$ if the value $\Delta\Theta$ is greater than 180°, and by adding 180° from the value $\Delta\Theta$ if the value $\Delta\Theta$ is less than -180° to obtain a wrap around adjusted value $\Delta\Theta$.

11. The method of claim 10, and further comprising:

determining whether a data bit has been received; and

if a data bit has been received, then further adjusting the wrap around adjusted value $\Delta\Theta$ to provide a data bit adjusted value $\Delta\Theta$ which is more closely representative of frequency error.

12. A global positioning system receiver having enhanced signal tracking after signal acquisition, the global positioning system receiver comprising:

signal separation circuitry configured to separate an acquired continuous time global positioning signal into in-phase and quadrature signals I and Q;

signal processing circuitry coupled to the signal separation circuitry and configured to sample the signals I and Q over a predetection interval (PDI) to provide discrete time signals and to generate from the discrete time signals a component in-phase measurement and a component quadrature measurement for each of a plurality of PDI segments of one PDI;

tracking circuitry coupled to the signal processing circuitry and configured to generate, for each of a plurality of different frequency bins and for a time corresponding to the PDI, a composite in-phase measurement and a composite quadrature measurement by combining component in-phase measurements and component quadrature measurements from the PDI; and

power detecting circuitry configured to detect power in each of the plurality of different frequency bins for the PDI using the corresponding composite in-phase measurement and the corresponding composite quadrature measurement generated for the frequency bin.

13. The global positioning system receiver of claim 12, wherein the signal processing circuitry is configured to sample the signals I and Q over a PDI of approximately 20 milliseconds to provide the discrete time signals.

14. The global positioning system receiver of claim 13, wherein a PDI is divided into five consecutive PDI segments and wherein the component in-phase measurements for each of the five PDI segments are I_1, I_2, I_3, I_4 and I_5, respectively, and wherein the component quadrature measurements for each of the five PDI segments are Q_1, Q_2, Q_3, Q_4 and Q_5, respectively.

15. The global positioning system receiver of claim 14, wherein the tracking circuitry is configured to generate the composite in-phase measurement and the composite quadrature measurement for each of five frequency bins by performing the steps of:

generating for a first frequency bin a composite in-phase measurement using the relationship $I_1-Q_2-I_3+Q_4+I_5$ and generating for the first frequency bin a composite quadrature measurement using the relationship $Q_1+I_2-Q_3-I_4+Q_5$;

generating for a second frequency bin a composite in-phase measurement using the relationship $I_1+I_2-Q_3-Q_4-I_5$ and generating for the second frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2+I_3+I_4-Q_5$;

generating for a third frequency bin a composite in-phase measurement using the relationship $I_1+I_2+I_3+I_4+I_5$ and generating for the third frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2+Q_3+Q_4+Q_5$;

generating for a fourth frequency bin a composite in-phase measurement using the relationship $I_1+I_2+Q_3+Q_4-I_5$ and generating for the fourth frequency bin a composite quadrature measurement using the relationship $Q_1+Q_2-I_3-I_4-Q_5$; and

generating for a fifth frequency bin a composite in-phase measurement using the relationship $I_1+Q_2-I_3-Q_4+I_5$ and generating for the fifth frequency bin a composite quadrature measurement using the relationship $Q_1-I_2-Q_3+I_4+Q_5$.

16. The global positioning system receiver of claim 12, wherein the power detection circuitry is configured to determine which one of the plurality of different frequency bins contains the most detected power.

17. The global positioning system receiver of claim 16, and further comprising a delay detector configured to apply a delay determining function to the composite in-phase measurement and the composite quadrature measurement for the frequency bin containing the most detected power to obtain a delay detector output.

18. The global positioning system receiver of claim 17, and further comprising feedback circuitry coupled to the delay detector and configured to provide a feedback output as a function of the delay detector output, wherein the signal separation circuitry is configured to separate the acquired continuous time global positioning signal into the in-phase and quadrature signals I and Q as a function of the feedback output.

19. The global positioning system receiver of claim 12, wherein the tracking circuitry is further adapted to generate for the PDI prompt versions of a composite in-phase measurement $X_p^{(0)}$ and a quadrature in-phase measurement $Y_p^{(0)}$ corresponding to a frequency bin having an estimated carrier frequency error of approximately zero, the receiver further comprising:

carrier phase computation circuitry configured to determine an arctangent of $Y_p^{(0)}/X_p^{(0)}$ to obtain a current carrier phase Θ, and to subtract a delayed version of the carrier phase Θ from the current carrier phase Θ to obtain a value $\Delta\Theta$, the carrier phase computation circuitry adjusting the value $\Delta\Theta$ if a data bit has occurred; and

carrier feedback circuitry coupled to the carrier phase computation circuitry and configured to provide a carrier feedback output as a function of the value $\Delta\Theta$, wherein the signal separation circuitry is further configured to separate the continuous time global positioning signal into the in-phase and quadrature signals I and Q as a function of the value $\Delta\Theta$.